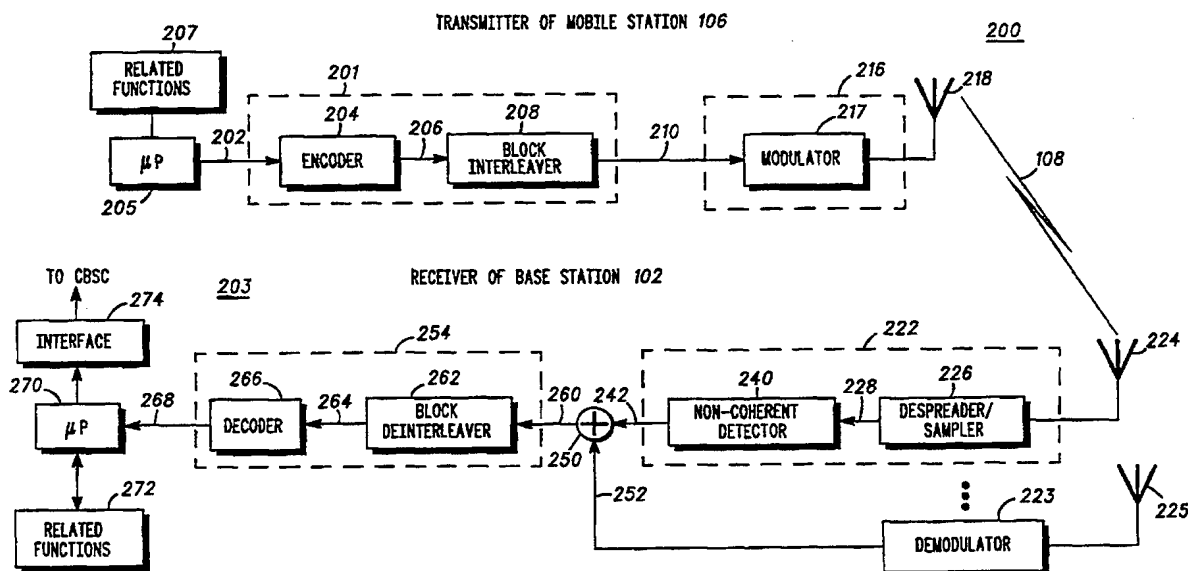




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04Q 7/12	A1	(11) International Publication Number: WO 96/42174 (43) International Publication Date: 27 December 1996 (27.12.96)
(21) International Application Number: PCT/US96/05998 (22) International Filing Date: 17 April 1996 (17.04.96) (30) Priority Data: 08/488,668 8 June 1995 (08.06.95) US (71) Applicant: MOTOROLA INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US). (72) Inventors: THORSON, Dean, Ernest; 727 Ascot Court, Hoffman Estates, IL 60194-2769 (US). DECLERCK, Daniel, Joseph; 1785 Charles Avenue, Algonquin, IL 60102 (US). (74) Agents: SONNENTAG, Richard, A. et al.; Motorola Inc., Intellectual Property Dept., 1303 East Algonquin Road, Schaumburg, IL 60196 (US).		(81) Designated States: CA, CN, DE, FI, GB, JP, KR, PL, SE. Published <i>With international search report.</i>

(54) Title: CHANGING A SERVICE OPTION IN A CDMA COMMUNICATION SYSTEM



(57) Abstract

A code division multiple access (CDMA) communication system (100) implements a service option change in a mobile station (106) by including data representing the service option to be employed in a handoff message (500) transmitted from a base station (102) to the mobile station (106). Use of the handoff message (500) as a medium to change a service option eliminates the cumbersome negotiation technique currently required to perform a service option change prior to handoff of the mobile station (106) from a first coverage area (104) to a second coverage area (110) or from a first channel to a second channel within a given coverage area (104).

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CHANGING A SERVICE OPTION IN A CDMA COMMUNICATION SYSTEM

5 Field of the Invention

The invention is generally related to code division multiple access communication systems, and more particularly to changing service option assignments in a code division multiple access
10 communication system.

Background of the Invention

15 Code Division Multiple Access (CDMA) communication systems are well known. In a CDMA communication system, communication between two communication units (e.g., a central communication site and a mobile communication unit) is accomplished by spreading each transmitted signal over the frequency band of the communication
20 channel with a unique user spreading code. Due to the spreading, transmitted signals are in the same frequency band of the communication channel and are separated only by unique user spreading codes. These unique user spreading codes preferably are orthogonal to one another such that the cross-correlation between the
25 spreading codes is approximately zero. Consequently, when the user spreading codes are orthogonal to one another, the received signal can be correlated with a particular user spreading code such that only the desired user signal (related to the particular spreading code) is despread.

It will be appreciated by those skilled in the art that several
30 different spreading codes exist which can be used to separate data signals from one another in a CDMA communication system. These spreading codes include, but are not limited to, pseudo noise (PN) codes

and Walsh codes. A Walsh code corresponds to a single row or column of the Hadamard matrix. For example, in a 64 channel CDMA spread spectrum system, particular mutually orthogonal Walsh codes can be selected from the set of 64 Walsh codes within a 64 by 64 Hadamard matrix. Also, a particular data signal can be separated from the other data signals by using a particular Walsh code to spread the particular data signal.

It will be further appreciated by those skilled in the art that spreading codes can be used to channel code data signals. The data signals are channel coded to improve performance of the communication system, and particularly radiotelephone communication systems, by enabling transmitted signals to better withstand the effects of various radiotelephone channel impairments, such as noise, fading, and jamming. Typically, channel coding reduces the probability of bit error, and/or reduces the required signal to noise ratio usually expressed as bit energy per noise density (E_b/N_0), to recover the signal at the cost of expending more bandwidth than would otherwise be necessary to transmit the data signal. For example, Walsh codes can be used to channel code a data signal prior to modulation of the data signal for subsequent transmission. Similarly psuedo-noise (PN) spreading codes can be used to channel code a data signal.

A typical CDMA transmission involves expanding the bandwidth of an information signal, transmitting the expanded signal and recovering the desired information signal by remapping the received spread spectrum into the original information signals bandwidth. This series of bandwidth trades used in CDMA transmission allows the CDMA communication system to deliver a relatively error-free information signal in a noisy signal environment or communication channel. The quality of recovery of the transmitted information signal from the communication channel is measured by the error rate (i.e., the number of errors in the recovery of the transmitted signal over a particular time span or received bit span) for

some E_b/N_0 . As the error rate increases the quality of the signal received by the receiving party decreases. As a result, communication systems typically are designed to limit the error rate to an upper bound or maximum so that the degradation in the quality of the received signal is limited.

In current CDMA communication systems, such as those defined by IS-95A ("Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System and published by the Electronic Industries Association (EIA), 2001 Eye Street, N.W., Washington, D.C. 20006) for Digital Cellular Systems (DCS) and ANSI-J-STD-8 for Personal Communication Systems (PCS), the capabilities of a base station and a mobile station can differ based upon their software and hardware configurations. One such example is in the area of available service options, which for IS-95A, are defined by TSB58. Each service option is defined by data representing the service option, and as defined in TSB58 for IS-95A, the data is a 16 bit field representing the service options.

There is no requirement that every service option be supported by every operator of a DCS/PCS. As such, when a mobile station communicating to a home base station enters a DCS/PCS which does not support a service option supported by the home DCS/PCS, the home base station is required to transmit messages to the mobile station to change to a service option supported by the target DCS/PCS. The current process of changing the service option is a cumbersome, time consuming negotiation technique, a technique which is incompatible with the goal of transparent mobile station handoffs when implemented in DCS/PCSs. Important to note is that the technique itself is cumbersome; when handoff is included, the overall service option change/handoff task is completely incompatible for a DCS/PCS.

For example, the current technique required to change a service option begins when the base station sends a *Service Request Message* to

the mobile station which proposes a change in service option. IS-95A allows a maximum time period of 5 seconds for the mobile station to respond to this message. The mobile station then responds with a *Service Response Message* which accepts the proposed change in service option. The base station may wait a maximum of .2 seconds for this message. The base station then sends a *Service Connect Message* which includes the data representation of the service option to be employed. The mobile station may wait a maximum of .4 seconds for this message. Finally, the mobile station responds with a *Service Connect Completion Message* which notifies the base station that the change in service option has been completed. At this point, the base station sends an *Extended Handoff Direction Message* to the mobile station. Since a handoff may take up to .4 seconds, the entire negotiation technique, from service option change to handoff, may result in up to 6 seconds of "dead time" over the air. This amount of "dead time" over the air will cause mobile stations to delay entering into soft handoff, which has the effect of increasing system interference and correspondingly decreasing system capacity.

Thus a need existing for a method and apparatus to efficiently change a service option in a CDMA communication system without effecting system capacity.

Brief Description of the Drawings

2 5

FIG. 1 generally depicts a CDMA communication system which may beneficially employ service option change in accordance with the invention.

FIG. 2 generally depicts a transmitter of a mobile station in CDMA communication with a receiver of a base station in a manner which may beneficially implement the present invention.

FIG. 3 generally depicts a transmitter of a base station in CDMA communication with a receiver of a mobile station in a manner which may beneficially implement the present invention.

FIG. 4 generally depicts the protocol layering structure for a
5 CDMA communication system.

FIG. 5 depicts an *Extended Handoff Direction Message* having the service option data representation therein in accordance with the invention.

10

Detailed Description of a Preferred Embodiment

A code division multiple access (CDMA) communication system implements a service option change in a mobile station by including
15 data representing the service option to be employed in a handoff message transmitted from a base station to the mobile station. Use of the handoff message as a medium to change a service option eliminates the cumbersome negotiation technique currently required to perform a service option change prior to handoff of the mobile station from a first
20 coverage area to a second coverage area or from a first channel to a second channel within a given coverage area.

Stated generally, a service option in a code division multiple access (CDMA) communication system is changed in a mobile station by first determining the service option to be employed by a mobile
25 station and transmitting, to the mobile station, data representing the service option in a preexisting message. In the preferred embodiment, the data representing the service option is a 16 bit field representing one of a plurality of service options, and the preexisting message is a handoff message, specifically an *Extended Handoff Direction Message*.
30 Also in the preferred embodiment, the transmitting of the data representation of the service option in a preexisting message is transparent to a physical layer on which the transmission occurs.

Referring now to FIG. 1, a CDMA communication system 100 which may beneficially employ service option change in accordance with the invention is depicted. A first base station 102 is located in a first coverage area 104 and communicates with a mobile station 106.

5 Communication is via a digital radio channel 108 which contains data information compatible with a CDMA communication system as defined by IS-95A. The mobile station 106 will maintain communication with the first base station 102 until the mobile station 106 nears the second coverage area 110.

10 As the mobile station 106 nears the second coverage area 110, a cellular handoff from the first base station 102 to the second base station 112 becomes necessary. In CDMA, a feature called "soft handoff" is supported. During soft handoff, the second base station 110 is notified in advance that it is the target of a cellular handoff, and as such is told
15 the transmission pattern that the mobile station 106 utilizes to communicate with the first base station 102. The second base station 112 will begin transmitting to the mobile station 106 with the same transmission pattern, and the mobile station 106 will detect/demodulate the transmission from both base stations 102, 112.
20 When the mobile determines that the second base station 112 provides better quality (based on thresholds), the base stations 102, 112 are so notified via the CDMA Base Site Controller (CBSC) 114. Communication from the first base station 102 to the mobile station 106 is terminated, and the second base station 112 assumes the
25 communication responsibilities. The handoff is termed "soft handoff" because, from the perspective of the mobile station 106, no break in communication has occurred.

When entrance of soft handoff is delayed (by having a lengthy combination of service option change/handoff procedure), the
30 threshold at which the mobile station 106 will initiate soft handoff is increased. This increase in threshold results in a correspondingly higher amount of power required to be transmitted by the mobile

station 106. As in any communication system, the higher the amount of power transmitted, the more interference the communication system will experience. In CDMA communication systems, an increase in system interference results in a decrease in system capacity, or the number of mobile stations 106 that may be served by any one base station 102, 112.

FIG. 2 generally depicts a transmitter 200 of the mobile station 106 in CDMA communication with a receiver 203 of the base station 102 in a manner which may beneficially implement the present invention. In the encoding portion 201 of the communication system, traffic channel data bits 202 originate from a microprocessor (μ P) 205, and are input to an encoder 204 at a particular bit rate (e.g., 9.6 kilobit/second). The μ P 205 is coupled to a block designated related functions 207, where functions including call processing, link establishment, and other general functions related to establishing and maintaining cellular communication are performed. The traffic channel data bits 202 can include either voice converted to data by a vocoder, pure data, or a combination of the two types of data. Encoder 204 encodes the traffic channel data bits 202 into data symbols 206 at a fixed encoding rate ($1/r$) with an encoding algorithm which facilitates subsequent maximum likelihood decoding of the data symbols into data bits (e.g., convolutional or block coding algorithms). For example, encoder 204 encodes traffic channel data bits 202 (e.g., 192 input data bits that were received at a rate of 9.6 kilobits/second) at a fixed encoding rate of one data bit to three data symbols (i.e., $1/3$) such that the encoder 204 outputs data symbols 206 (e.g., 576 data symbols output at a 28.8 kilo symbols/second rate).

The data symbols 206 are then input into an interleaver 208. Interleaver 208 organizes the data symbols 206 into blocks (i.e., frames) and block interleaves the input data symbols 206 at the symbol level. In the interleaver 208, the data symbols are individually input into a matrix which defines a predetermined size block of data symbols. The

data symbols are input into locations within the matrix so that the matrix is filled in a column by column manner. The data symbols are individually output from locations within the matrix so that the matrix is emptied in a row by row manner. Typically, the matrix is a square
5 matrix having a number of rows equal to the number of columns; however, other matrix forms can be chosen to increase the output interleaving distance between the consecutively input non-interleaved data symbols. The interleaved data symbols 110 are output by the interleaver 208 at the same data symbol rate that they were input (e.g.,
10 28.8 kilo symbols/second). The predetermined size of the block of data symbols defined by the matrix is derived from the maximum number of data symbols which can be transmitted at a coded bit rate within a predetermined length transmission block. For example, if data symbols 206 are output from the encoder 204 at a 28.8 kilo symbols/second rate,
15 and if the predetermined length of the transmission block is 20 milliseconds, then the predetermined size of the block of data symbols is 28.8 kilo symbols/second times 20 milliseconds (ms) which equals 576 data symbols which defines a 18 by 32 matrix.

The encoded, interleaved data symbols 210 is output from
20 encoding portion 201 of the communication system and input to a transmitting portion 216 of the communication system. The data symbols 210 are prepared for transmission over a communication channel by a modulator 217. Subsequently, the modulated signal is provided to an antenna 218 for transmission over the digital radio
25 channel 108.

The modulator 217 prepares the data symbols 210 for direct sequence code divided spread-spectrum transmission by deriving a sequence of fixed length codes from the encoded, interleaved data symbols 210 in a spreading process. For example, the data symbols
30 within the stream of reference-coded data symbols 210 may be spread to a unique fixed length code such that a group of six data symbols is represented by a single 64 bit length code. The codes representing the

group of six data symbols preferably are combined to form a single 64 bit length code. As a result of this spreading process, the modulator 217 which received the encoded, interleaved data symbols 210 at a fixed rate (e.g., 28.8 kilo symbols/second) now has a spread sequence of 64 bit
5 length codes having a higher fixed symbol rate (e.g., 307.2 kilo symbols/second). It will be appreciated by those skilled in the art that the data symbols within the stream of encoded, interleaved data bits 210 may be spread according to numerous other algorithms into a sequence of larger length codes without departing from the scope and
10 spirit of the present invention.

The spread sequence is further prepared for direct sequence code divided spread-spectrum transmission by further spreading the spread sequence with a long spreading code (e.g., PN code). The spreading code is a user specific sequence of symbols or unique user code which is
15 output at a fixed chip rate (e.g., 1.228 Megachips/second). In addition to providing an identification as to which user sent the encoded traffic channel data bits 202 over the digital radio channel 108, the unique user code enhances the security of the communication in the communication channel by scrambling the encoded traffic channel data
20 bits 202. In addition, the user code spread encoded data bits (i.e., data symbols) are used to bi-phase modulate a sinusoid by driving the phase controls of the sinusoid. The sinusoid output signal is bandpass filtered, translated to an RF frequency, amplified, filtered and radiated by an antenna 218 to complete transmission of the traffic channel data
25 bits 202 in a digital radio channel 108 with Binary Phase Shift Keyed (BPSK) modulation.

A receiving portion 222 of the base station receiver 203 receives the transmitted spread-spectrum signal from over the digital radio channel 108 through antenna 224. The received signal is sampled into
30 data samples by despreaders and sampler 226. Subsequently, the data samples 242 are output to the decoding portion 254 of the communication system.

The despreader and sampler 226 preferably BPSK samples the received spread-spectrum signal by filtering, demodulating, translating from the RF frequencies, and sampling at a predetermined rate (e.g., 1.2288 Megasamples/second). Subsequently, the BPSK sampled signal is
5 despread by correlating the received sampled signals with the long spreading code. The resulting despread sampled signal 228 is sampled at a predetermined rate and output to a non-coherent detector 240 (e.g., 307.2 kilo samples/second so that a sequence of four samples of the received spread-spectrum signal is despread and/or represented by a
10 single data sample) for later non-coherent detection of data samples 242.

As will be appreciated by those skilled in the art, multiple receiving portions 222 through 223 and antennae 224 through 225, respectively, can be used to achieve space diversity. The Nth receiver portion would operate in substantially the same manner to retrieve
15 data samples from the received spread-spectrum signal in digital radio channel 108 as the above described receiving portion 222. The outputs 242 through 252 of the N receiving portions preferably are input to a summer 250 which diversity combines the input data samples into a composite stream of coherently detected data samples 260.

20 The individual data samples 260 which form soft decision data are then input into a decoding portion 254 including a deinterleaver 262 which deinterleaves the input soft decision data 260 at the individual data level. In the deinterleaver 262, the soft decision data 260 are individually input into a matrix which defines a predetermined
25 size block of soft decision data. The soft decision data are input into locations within the matrix so that the matrix is filled in a row by row manner. The deinterleaved soft decision data 264 are individually output from locations within the matrix so that the matrix is emptied in a column by column manner. The deinterleaved soft decision data
30 264 are output by the deinterleaver 262 at the same rate that they were input (e.g., 28.8 kilometrics/second).

The predetermined size of the block of soft decision data defined by the matrix is derived from the maximum rate of sampling data samples from the spread-spectrum signal received within the predetermined length transmission block.

5 The deinterleaved soft decision data 264, are input to a decoder 266 which uses maximum likelihood decoding techniques to generate estimated traffic channel data bits 268. The maximum likelihood decoding techniques may be augmented by using an algorithm which is substantially similar to a Viterbi decoding algorithm. The decoder 266
10 uses a group of the individual soft decision data 264 to form a set of soft decision transition metrics for use at each particular time state of the maximum likelihood sequence estimation decoder 266. The number of soft decision data 264 in the group used to form each set of soft decision transition metrics corresponds to the number of data symbols 206 at the
15 output of the convolutional encoder 204 generated from each input data bit 202. The number of soft decision transition metrics in each set is equal to two raised to the power of the number of soft decision data 264 in each group. For example, when a 1/3 convolutional encoder is used in the transmitter, three data symbols 106 are generated from each
20 input data bit 202. Thus, decoder 266 uses groups of three individual soft decision data 264 to form eight soft decision transition metrics for use at each time state in the maximum likelihood sequence estimation decoder 266. The estimated traffic channel data bits 268 are generated at a rate related to the rate that the soft decision data 264 are input to the
25 decoder 266 and the fixed rate used to originally encode the input data bits 202 (e.g., if the soft decision data are input at 28.8 kilometrics/second and the original encoding rate was 1/3 then estimated traffic channel data bits 268 are output at a rate of 9600 bits/second).

30 The estimated traffic channel data bits 268 are input into a μ P 270, which is similar to μ P 207. As in the case of μ P 207, the μ P 270 is coupled to a block designated related functions 272, this block also

performing functions including call processing, link establishment, and other general functions related to establishing and maintaining cellular communication. The μ P 270 is also coupled to an interface 274, which allows the receiver 203 of the base station 102 to communicate with the
5 CBSC 114.

FIG. 3 generally depicts a transmitter 300 of the base station 102 in CDMA communication with a receiver 303 of the mobile station 106 in a manner which may beneficially implement the present invention. In the encoding portion 301 of the communication system, traffic channel
10 data bits 302 are output from a μ P 305, and are input to an encoder 304 at a particular bit rate (e.g., 9.6 kilobit/second). The μ P 305 is coupled to a block designated related functions 307, which performs similar cellular-related functions as blocks 207 and 272 of FIG. 2. The μ P 305 is also coupled to an interface 309 which allows the transmitter 300 of base
15 station 102 to communicate with the CBSC 114.

The traffic channel data bits 302 can include either voice converted to data by a vocoder, pure data, or a combination of the two types of data. Encoder 304 encodes the traffic channel data bits 302 into data symbols 306 at a fixed encoding rate $(1/r)$ with an encoding
20 algorithm which facilitates subsequent maximum likelihood decoding of the data symbols into data bits (e.g., convolutional or block coding algorithms). For example, encoder 304 encodes traffic channel data bits 302 (e.g., 192 input data bits that were received at a rate of 9.6 kilobits/second) at a fixed encoding rate of one data bit to two data
25 symbols (i.e., $1/2$) such that the encoder 304 outputs data symbols 306 (e.g., 384 data symbols output at a 19.2 kilo symbols/second rate).

The data symbols 306 are then input into an interleaver 308. Interleaver 308 organizes the data symbols 306 into blocks (i.e., frames) and block interleaves the input data symbols 306 at the symbol level. In
30 the interleaver 308, the data symbols are individually input into a matrix which defines a predetermined size block of data symbols. The data symbols are input into locations within the matrix so that the

matrix is filled in a column by column manner. The data symbols are individually output from locations within the matrix so that the matrix is emptied in a row by row manner. Typically, the matrix is a square matrix having a number of rows equal to the number of columns; however, other matrix forms can be chosen to increase the output interleaving distance between the consecutively input non-interleaved data symbols. The interleaved data symbols 310 are output by the interleaver 308 at the same data symbol rate that they were input (e.g., 19.2 kilo symbols/second). The predetermined size of the block of data symbols defined by the matrix is derived from the maximum number of data symbols which can be transmitted at a coded bit rate within a predetermined length transmission block. For example, if data symbols 306 are output from the encoder 304 at a 19.2 kilo symbols/second rate, and if the predetermined length of the transmission block is 20 milliseconds, then the predetermined size of the block of data symbols is 19.2 kilo symbols/second times 20 milliseconds (ms) which equals 384 data symbols which defines a 18 by 32 matrix.

The encoded, interleaved data symbols 310 are output from encoding portion 307 of the communication system and input to a transmitting portion 316 of the communication system. The data symbols 310 are prepared for transmission over a communication channel by a modulator 317. Subsequently, the modulated signal is provided to an antenna 318 for transmission over the digital radio channel 108.

The modulator 317 prepares the data symbols 310 for direct sequence code divided spread-spectrum transmission by performing data scrambling on the encoded, interleaved data symbols 310. Data scrambling is accomplished by performing the modulo-2 addition of the interleaver output symbols 310 with the binary value of a long code pseudo-noise PN chip that is valid at the start of the transmission period for that symbol. This pseudo-noise PN sequence is the equivalent of the long code operating at 1.2288 MHz clock rate, where

only the first output of every 64 is used for the data scrambling (i.e., at a 19200 sample per second rate).

After scrambling, a sequence of fixed length codes from the scrambled data symbols are derived in a spreading process. For example, each data symbol within the stream of scrambled data symbols may preferably be spread to a unique fixed length code such that each data symbol is represented by a single 64 bit length code. The code representing the data symbol preferably is modulo-2 added to the respective data symbol. As a result of this spreading process, the modulator 317 which received the encoded, interleaved data symbols 310 at a fixed rate (e.g., 19.2 kilo symbols/second) now has a spread sequence of 64 bit length codes having a higher fixed symbol rate (e.g., 1228.8 kilo symbols/second). It will be appreciated by those skilled in the art that the data symbols within the stream of encoded, interleaved data bits 310 may be spread according to numerous other algorithms into a sequence of larger length codes without departing from the scope and spirit of the present invention.

The spread sequence is further prepared for direct sequence code divided spread-spectrum transmission by further spreading the spread sequence with a long spreading code (e.g., PN code). The spreading code is a user specific sequence of symbols or unique user code which is output at a fixed chip rate (e.g., 1.2288 Megachips/second). In addition to providing an identification as to which user sent the encoded traffic channel data bits 302 over the digital radio channel 308, the unique user code enhances the security of the communication in the communication channel by scrambling the encoded traffic channel data bits 302. In addition, the user code spread encoded data bits (i.e., data symbols) are used to bi-phase modulate a sinusoid by driving the phase controls of the sinusoid. The sinusoid output signal is bandpass filtered, translated to an RF frequency, amplified, filtered and radiated by an antenna 318 to complete transmission of the traffic channel data bits 302 in a digital radio channel 108 with BPSK modulation.

A receiving portion 322 of the mobile station receiver 303 receives the transmitted spread-spectrum signal from over the digital radio channel 108 through antenna 324. The received signal is sampled into data samples by desreader and sampler 326. Subsequently, the
5 data samples 342 are output to the decoding portion 354 of the communication system.

The desreader and sampler 326 preferably BPSK samples the received spread-spectrum signal by filtering, demodulating, translating from the RF frequencies, and sampling at a predetermined rate (e.g.,
1 0 1.2288 Megasamples/second). Subsequently, the BPSK sampled signal is despread by correlating the received sampled signals with the long spreading code. The resulting despread sampled signal 328 is sampled at a predetermined rate and output to a non-coherent detector 340 (e.g.,
1 5 19.2 kilo samples/second so that a sequence of 64 samples of the received spread-spectrum signal is despread and/or represented by a single data sample) for non-coherent detection of data samples 342.

As will be appreciated by those skilled in the art, multiple receiving portions 322 through 323 and antennae 324 through 325, respectively, can be used to achieve space diversity. The Nth receiver
2 0 portion would operate in substantially the same manner to retrieve data samples from the received spread-spectrum signal in digital radio channel 320 as the above described receiving portion 322. The outputs 342 through 352 of the N receiving portions preferably are input to a summer 350 which diversity combines the input data samples into a
2 5 composite stream of coherently detected data samples 360.

The individual data samples 360 which form soft decision data are then input into a decoding portion 354 including a deinterleaver 362 which deinterleaves the input soft decision data 360 at the individual data level. In the deinterleaver 362, the soft decision data
3 0 360 are individually input into a matrix which defines a predetermined size block of soft decision data. The soft decision data are input into locations within the matrix so that the matrix is filled in a row by row

manner. The deinterleaved soft decision data 364 are individually output from locations within the matrix so that the matrix is emptied in a column by column manner. The deinterleaved soft decision data 364 are output by the deinterleaver 362 at the same rate that they were input (e.g., 19.2 kilometrics/second).

The predetermined size of the block of soft decision data defined by the matrix is derived from the maximum rate of sampling data samples from the spread-spectrum signal received within the predetermined length transmission block.

The deinterleaved soft decision data 364, are input to a decoder 366 which uses maximum likelihood decoding techniques to generate estimated traffic channel data bits 368. The maximum likelihood decoding techniques may be augmented by using an algorithm which is substantially similar to a Viterbi decoding algorithm. The decoder 366 uses a group of the individual soft decision data 364 to form a set of soft decision transition metrics for use at each particular time state of the maximum likelihood sequence estimation decoder 366. The number of soft decision data 364 in the group used to form each set of soft decision transition metrics corresponds to the number of data symbols 306 at the output of the convolutional encoder 304 generated from each input data bit 302. The number of soft decision transition metrics in each set is equal to two raised to the power of the number of soft decision data 364 in each group. For example, when a 1/2 convolutional encoder is used in the transmitter, two data symbols 306 are generated from each input data bit 302. Thus, decoder 366 uses groups of two individual soft decision data 364 to form four soft decision transition metrics for use at each time state in the maximum likelihood sequence estimation decoder 366. The estimated traffic channel data bits 368 are generated at a rate related to the rate that the soft decision data 364 are input to the decoder 366 and the fixed rate used to originally encode the input data bits 302 (e.g., if the soft decision data are input at 19.2 kilometrics/second and the original encoding rate was 1/2 then

estimated traffic channel data bits 368 are output at a rate of 9600 bits/second). The estimated traffic channel data bits 368 are input into a μ P 370 which interprets the estimated traffic channel data bits 368 and other fields, including the fields of an *Extended Handoff Direction*
5 *Message*, transmitted in the digital radio channel 108. The μ P 370 is coupled to related functions 372 which performs cellular-related functions similar to those performed by blocks 207, 272 and 307.

FIG. 4 generally depicts the protocol layering structure for a CDMA communication system. As shown in FIG. 4, the protocol is
10 logically divided into conceptual layers. Layer 1 400, or the physical layer of the digital radio channel 108, includes those functions associated with the transmission of bits. These functions include modulation, coding, framing, and channelization via radio waves. A multiplex sublayer 402 provides the multiplexing functions which
15 allow sharing of the digital radio channel 108 for user data and signaling processes. Signaling protocol layer 2 is subdivided into a primary traffic layer 2 404 and a secondary traffic layer 2 406, and is the protocol associated with the reliable delivery of signaling higher layer messages (for example, from upper layers 408, 410) between the base
20 station 102 and the mobile station 106. Such upper layer signaling messages include message retransmission and duplicate detection.

As previously mentioned, service options for IS-95A are defined by TSB58, and currently include basic variable rate voice service (8 kbps), mobile station loopback, enhanced variable rate voice service (8
25 kbps), asynchronous data service, group 3 facsimile, short message services, transmission control protocol/internet protocol packet data service, and Cellular Digital Packet Data (CDPD) over point-to-point (PPP) packet data service. All protocol layering above multiplex sublayer 402 is service option dependent. In other words, signaling
30 from the base station 102 to the mobile station 106 to change a service option is performed at layer 2 404, 406 or above.

Another parameter which is transmitted to the mobile station 106 by the base station 102 is a parameter called the rate set, which is used to define the data rate used over the digital radio channel 108. IS-95A currently defines two rate set parameters, rate set 1 and rate set 2, and each rate set has its own set of service options. Since a rate set change would alter the digital radio channel 108 (by changing the vocoding rate over the channel, and hence the bandwidth of the channel), a rate set change is not transparent to layer 1 400, the physical layer which supports the digital radio channel 108. However, once the rate set parameter is set, a service option can be changed without altering the physical layer. In other words, any service option change for a given rate set is transparent to layer 1 400, the physical layer which supports the digital radio channel 108.

As previously stated, a service option in a code division multiple access (CDMA) communication system 100 is changed in a mobile station 106 in accordance with the invention by first determining the service option to be employed by the mobile station 106 and transmitting, to the mobile station 106, data representing the service option in a preexisting message. In the preferred embodiment, the data representing the service option is a 16 bit field representing one of a plurality of service options, and the preexisting message is an *Extended Handoff Direction Message*. FIG. 5 depicts a handoff message, and specifically an *Extended Handoff Direction Message* 500 having both data related to handoff and the service option data representation therein in accordance with the invention. As shown in FIG. 5, the message 500 has an *Additional Fields* field 502 which is reserved for use by a base/mobile station manufacturer to use as required, and is 16 bits in length. In the preferred embodiment of the present invention, field 502 in the message 500 contains the 16 bit service option data representation utilized to change the service option in the mobile station. Since a change in service option occurs at layer 2 and above (as best seen in FIG. 4), the *Additional Fields* field 502 may contain a

service option for either primary traffic layer 2 404 (as represented by the data field 504) or secondary traffic layer 2 406 (as represented by the data field 506) .

5 Certain time division multiple access (TDMA) communication systems, such as the European Digital Cellular System (Global System for Mobile Communication, or GSM) and the Japanese Digital Cellular System (Personal Digital Cellular, or PDC) use a handoff message to change certain layer 1 characteristics; i.e., the characteristics related to the digital radio channel 108. However, as discussed above, a service
1 0 option change in a CDMA communication system, for a given rate set, is completely transparent to the digital radio channel 108 since all signalling related to the service option change is performed at layer 2 404, 406 or above.

1 5 A typical example of how a service option might be changed in a mobile station is provided as follows, with reference to FIG. 1. Assuming mobile station 106 was located within a first coverage area 104 and was communicating to a first base station 102 which supports a first set of service options, and was entering a second coverage area 110 serviced by a second base station 112 which supports a second set of
2 0 service options, then the first base station 102 would first identify that a cellular handoff is necessary. Notwithstanding the service option requirement, the cellular handoff is necessary to allow the mobile station 106 to maintain communication from the first coverage area 104 to the second coverage area 110.

2 5 At this point, since the first base station 102 is aware that a cellular handoff is necessary, the first base station 102 can also determine the service option to be employed and check whether the second base station 112 supports the determined service option. This step is necessary since the second base station 112 may be a base station
3 0 of a different operator which has chosen to support different service options. As one of ordinary skill in the art will appreciate, the available service option information may reside at either the first base station 102

or the CBSC 114. Continuing, based on the determination, the first base station 102 will insert the data representation of the determined service option into the *Additional Fields* field 502 of the *Extended Handoff Direction Message* 500, and will transmit the *Extended Handoff Direction Message* 500 to mobile station 106. The mobile station 106 will receive the *Extended Handoff Direction Message* 500, and send the data within the message to μ P 370 for interpretation. The μ P 370 interprets the data received, changes the service option based on the data representation in the *Additional Fields* field 502, and alters the receiver 303 of the mobile station 106 so as to perform a cellular handoff in accordance with the invention.

As one of ordinary skill in the art will appreciate, service option change in accordance with the invention is not limited to intercell handoff as described above. For example, service option change in accordance with the invention may be beneficially applied to intracell handoffs. Referring to FIG. 1, the mobile station 106 may require a intracell handoff because of restraints placed on the system. As an example, capacity restraints may limit the service options supported by a given base station 102. During times of high system capacity (peak times during the day), the base station 102 could be designed to not support certain channel-time consuming service options, such as group 3 facsimile. When system capacity is lessened (off peak times of the day), the base station 102 would then allow all service options to be supported. These system restraints can be provided for in a manner that is transparent to the digital radio channel 108 supported by the protocol of layer 1 400.

Since no additional time is required to perform the cumbersome negotiation process of the prior art, the CDMA communication system in accordance with the invention performs a service option change without incurring an increase in the rate of dropped calls. Additionally, since all signalling occurs at layer 2 404, 406 or above, the service option change in accordance with the invention is transparent

to the digital radio channel 108 supported by the protocol of layer 1 400.
Finally, since the mobile station 106 does not delay in entering soft
handoff, system interference is reduced, which results in a
corresponding increase in system capacity when compared to the prior
5 art method of service option change.

While the invention has been particularly shown and described
with reference to a particular embodiment, it will be understood by
those skilled in the art that various changes in form and details may be
made therein without departing from the spirit and scope of the
10 invention.

What we claim is:

Claims

1. A method of changing a service option in a code division
5 multiple access (CDMA) communication system, the method
comprising the steps of:
- determining a service option to be employed by a mobile station;
and
10 transmitting, to the mobile station, data representing the service
option in a preexisting message.
2. The method of claim 1 wherein the data representing the service
option further comprises a 16 bit field representing one of a plurality of
15 service options.
3. The method of claim 1 wherein the preexisting message further
comprises a handoff message.
- 20 4. The method of claim 1 wherein the step of transmitting a data
representation of the service option in a preexisting message is
transparent to a physical layer on which the step of transmitting occurs.

5. A method of changing a service option in a mobile station, the mobile station in communication with a CDMA communication system base station, the method comprising the steps of:
- 5 receiving, in a handoff message transmitted from the base station, data representing the service option to be employed; and
changing the service option in the mobile station based on the data received in the handoff message.
- 10 6. The method of claim 5 wherein the step of changing the service option is transparent to a physical resource on which the handoff message is transmitted.

7. A method of changing a service option in a mobile station, the mobile station compatible with a CDMA communication system, the mobile station in communication with the first base station and requiring a handoff from the first base station to a second base station,
5 the mobile station implementing a current service option supported by the first base station, the method comprising the steps of:

at the first base station:

- 1 0 determining the service option to be employed by the second base station;

inserting a data representation of the determined service option into a handoff message; and

transmitting the handoff message to the mobile station when the handoff is required;

- 1 5 at the mobile station:

receiving the handoff message from the first base station;

changing the service option based on the data representation;

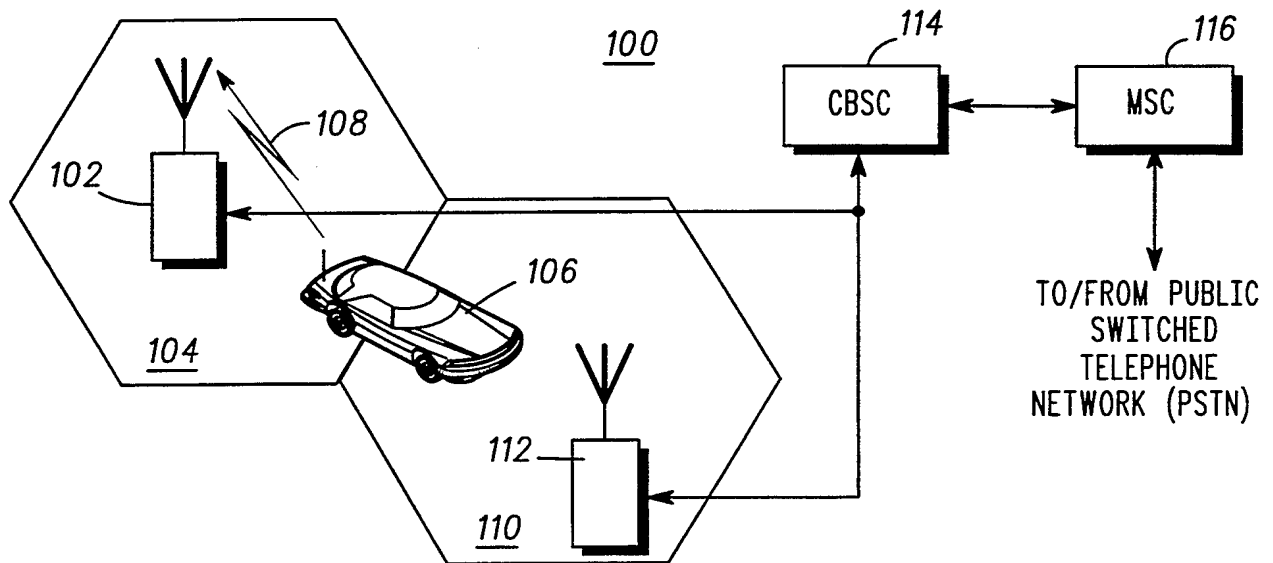
and

- 2 0 changing communication from the first base station to the second base station based on the handoff message.

8. The method of claim 7, wherein the first base station and the second base station of the CDMA communication support soft handoff.

9. A mobile station which supports a plurality of service options, the mobile station compatible with a code division multiple access (CDMA) communication system, the mobile station comprising:
- 5 a receiver for receiving a handoff message containing a data representation of a service option and data related to a communication handoff; and
- a microprocessor for interpreting the handoff message so as to implement the service option corresponding to the data representation
- 10 and for altering the receiver of the mobile station so as to perform the communication handoff.
10. The mobile station of claim 9 wherein the handoff message is a handoff message related to a intercell handoff or an intracell handoff.

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*FIG. 1*

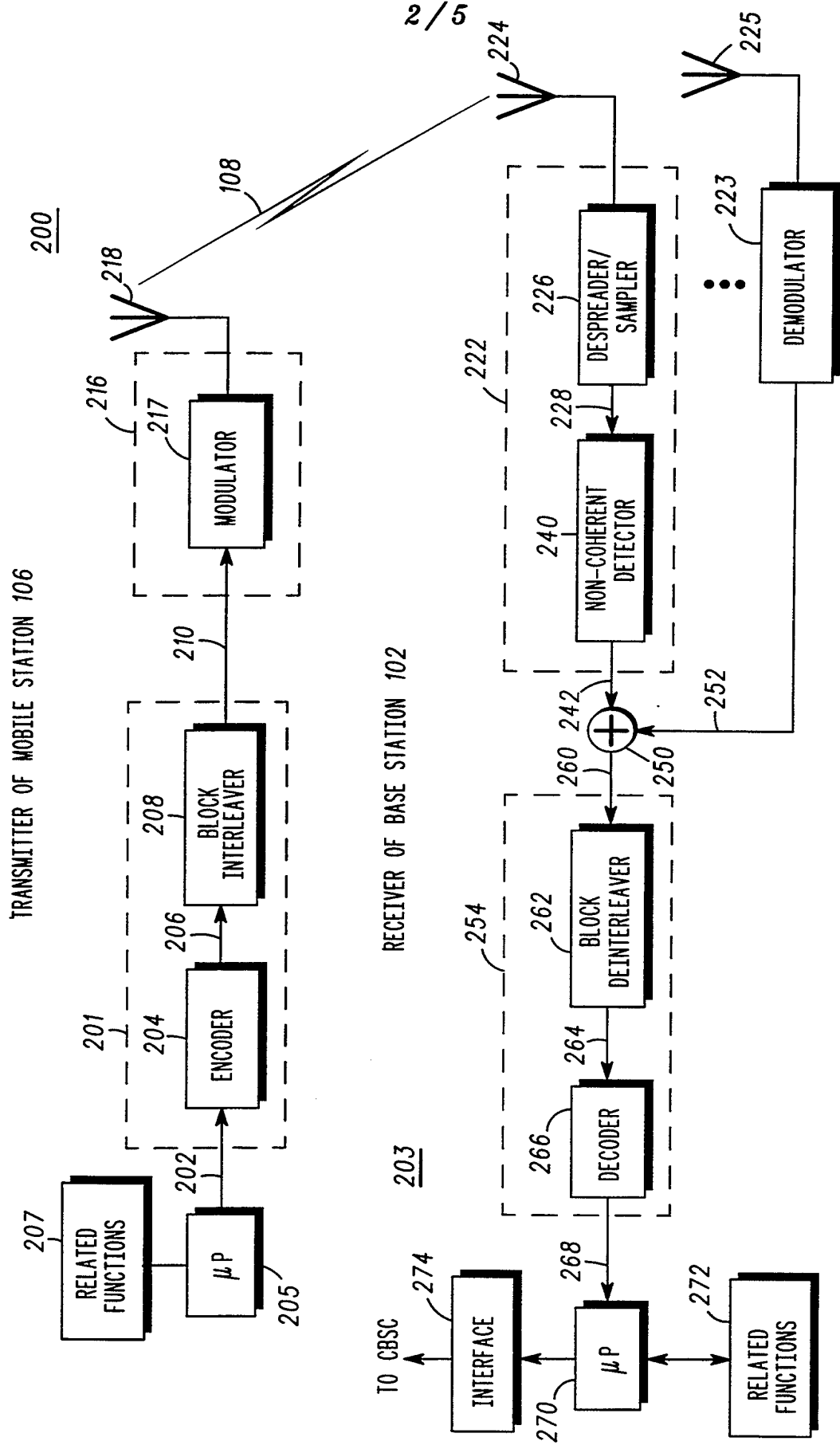


FIG. 2

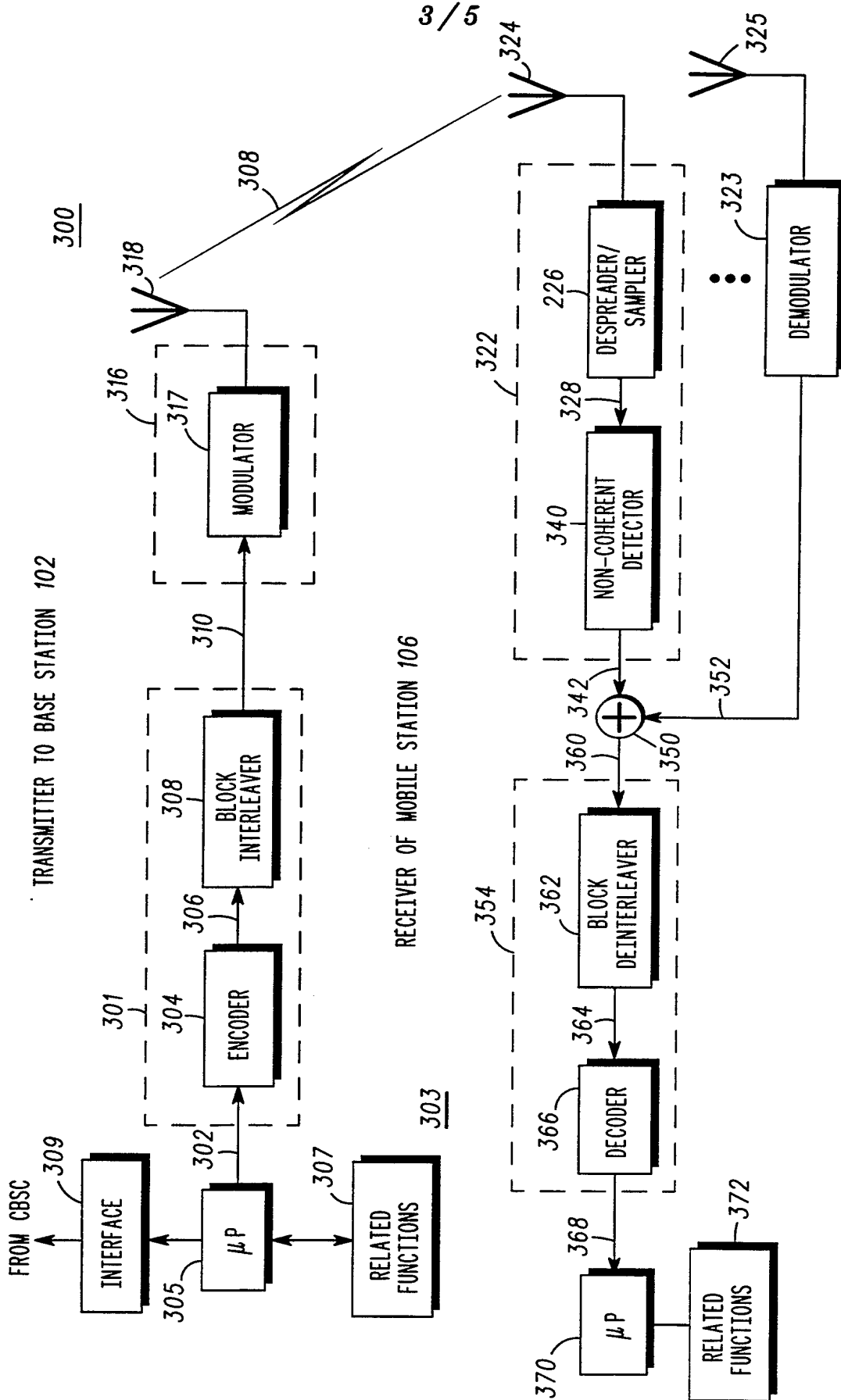


FIG. 3

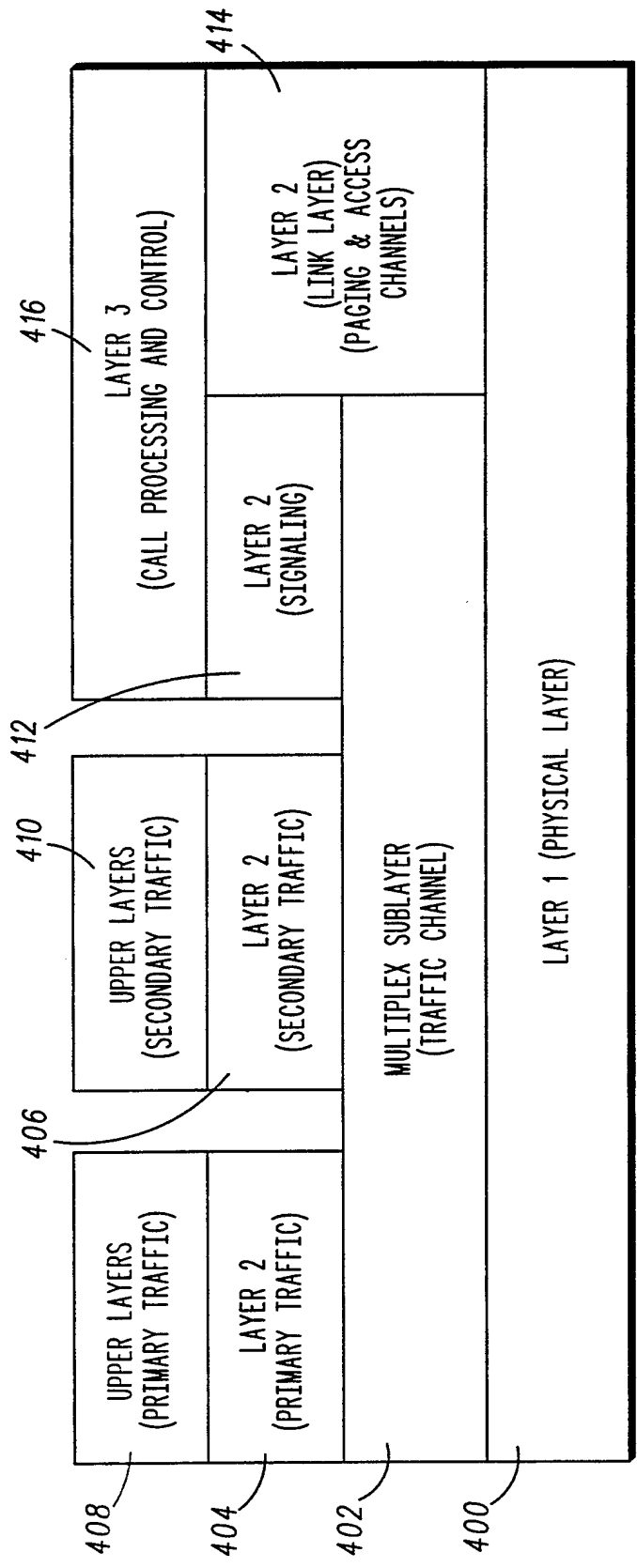


FIG. 3

FIG. 5

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500

FIELD	LENGTH (BI
MSG_TYPE ('00010001')	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
USE_TIME	1
ACTION_TIME	6
HDM_SEQ	2
SEARCH_INCLUDED	1
SRCH_WIN_A	0 OR 4
T_ADD	0 OR 6
T_DROP	0 OR 6
T_COMP	0 OR 4
T_TDROP	0 OR 4
HARD_INCLUDED	1
FRAME_OFFSET	0 OR 4
PRIVATE_LCM	0 OR 1
RESET_L2	0 OR 1
RESET_FPC	0 OR 1
RESERVED	0 OR 1
SERV_NEG_TYPE	0 OR 1
ENCRYPT_MODE	0 OR 2
RESERVED	0 OR 1
NOM_PWR	0 OR 4
NUM_PREAMBLE	0 OR 3
BAND_CLASS	0 OR 5
CDMA_FREQ	0 OR 11
ADD_LENGTH	3
ADD_FIELD_TYPES	0 OR 8
ADDITIONAL FIELDS	0 OR 8 X (ADD_LENGTH - 1)

502

504

CONTENTS OF THE ADDITIONAL FIELDS RECORDS:

506

PRIMARY_SERV_OPT	0 OR 16
SECONDARY_SERV_OPT	0 OR 16

INTERNATIONAL SEARCH REPORT

 International application No.
 PCT/US96/05998

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04Q 7/12

US CL :379/59, 60; 455/33.1, 33.2

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/59, 60; 455/33.1, 33.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 5,267,261 (BLAKENEY, II ET AL) 30 NOVEMBER 1993, col. 5, line 57 to col. 6, line 5; col. 8, lines 46-58; col. 13, line 65 to col.15, line 2; col. 31, lines 1-58; background of the invention.	1, 3, 5 and 7-14 ----- 2, 4, and 6
Y	US, A, 5,313,461 (AHL ET AL) 17 JUNE 1994, col. 7, line 57 to col. 8, line 8; col. 17, lines 19-21.	2, 4, and 6

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

08 JUNE 1996

Date of mailing of the international search report

11 JUL 1996

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